Concussion Management: The Role for Audiology

By Nina Kraus, PhD, and Travis White-Schwoch

Concussions have captured the public interest. Many scientists and physicians are on the quest for a gold standard test that can objectively identify a concussion with complete confidence. Unfortunately, concussions are too complex to be identified by just one test. As such, there is a growing trend to move to multidisciplinary concussion care. Recent research shows that audiologists can fill a key role in this paradigm.

WHAT IS A CONCUSSION?

A concussion is a brain injury. Diagnostic criteria for a concussion are a cluster of symptoms caused by a direct blow to the head or body that results in one or more symptoms in one or more domains spanning sensory, somatic, cognitive, emotional, and/or sleep disturbances. This definition might make one wonder: What *isn't* a concussion? Concussion symptoms may not be explained by factors such as a cold, substance use, or other physiological disturbances. Concussions also explicitly rule out brain bleeds or skull fractures.

Still, it can be challenging to make a concussion diagnosis with confidence. It can be even more challenging to conclude that a patient has recovered from a concussion, largely because many of the classic concussion symptoms can be relatively benign. We all get headaches from time to time. If a patient wakes up with a headache the day she goes to the doctor for her follow-up, does that mean she is still experiencing concussion symptoms?

This ambiguity has led to an interest in objective signs that health care providers can evaluate in tandem with subjective symptoms. Tests of neurosensory function—particularly auditory, visual, and vestibular tests—have already shown promise.

SENSORY CONSEQUENCES

Concussions acutely disrupt many brain functions. It appears that neurosensory functions are particularly sensitive. Peripheral sensory functions tend to be normal, whereas sensory functions requiring fine-grained neural processing have shown promise. One of the first domains of research was vision. Following a concussion, visual acuity is typically normal, but the ability of the eyes to work together to track moving objects is disrupted. The story seems similar for balance. Following a concussion, patients can stand with two feet on the floor easily; but, they wobble when they try to stand on one leg on a foam pad.

The pattern of "peripheral is normal, neural is struggling" reminded us of a typical profile of a patient who struggles with speech-in-noise perception. This made us hypothesize that auditory processing tests are also sensitive to concussions. Children with concussions struggle to understand sentences in noise (*Brain Inj.* 2018;32[6]:663-769) and have diminished neural responses to speech (*Sci Rep.* 2016;6:39009) despite intact peripheral auditory function.

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NEUROSENSORY TESTS IN CONCUSSION EVALUATIONS

To better understand the role neurosensory tests could play in clinical evaluations, we recently completed a longitudinal study of youth tackle football players (*Brain Inj.* 2020;34:236-244; *Concussion.* 2020;66:1-17). For two years, 100 male participants between 7 and 14 years old were enrolled in this study before and after their football seasons. We measured their neurosensory performance across three domains:

1. Auditory: Frequency-following responses (FFRs) to speech measure the integrity of sound processing in the auditory system.

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2. Vestibular: Balance Error Scoring System (BESS) requires subjects to hold several postures on stable and unstable surfaces.
3. Visual: King-Devick (KD) tests require subjects to recite lists of printed letters or numbers as quickly and accurately as possible.

Of the 100 participants, one had sustained a concussion. As expected, he exhibited acute disruptions in all three domains that recovered as he healed from his injury. We were also interested in the outcomes of the football participants who did not sustain a concussion. Here are our three main findings:

First, the youth tackle football players performed normally when healthy. At both pre-season baselines, football players' performance on the three domains was consistent with previously published studies. This is important because it supports the use of these tests in clinical contexts. Stated differently, the administration of these tests is not contaminated by the "What if I woke up today with a headache" problem of baseline symptom reporting.

Second, each domain adds a distinct piece of information. At pre-season, there were no correlations between the FFR, BESS, and KD. For example, a child who performed relatively well on the FFR did not necessarily perform relatively well on the other tests. The fact that these tests are not related in healthy children reinforces the use of multidisciplinary concussion assessments.

Third, neurosensory function was stable for up to two consecutive seasons of tackle football. In the children who did not sustain a concussion, we observed no reliable changes in their performance across the tests. This suggests that, in the absence of an injury, participation in tackle football does result in short-term disruptions in sensory function.

These results should be interpreted with caution since they are from a relatively small study, only involved boys, and were restricted to participants in one sport. Nonetheless, these results lend credence to the use of neurosensory testing in concussion management. Audiologists have an important role to play in multidisciplinary care teams given their expertise in the evaluation of auditory function.

To learn more about concussions and auditory processing, visit https://brainvolts.northwestern.edu/concussion/.